

# How much exposure to English is necessary for a bilingual toddler to perform like a monolingual peer in language tests?

Cattani, Allegra; Abbot-Smith, Kirsten; Farag, Rafalla; Krott, Andrea; Arreckx, Frederique; Dennis, Ian; Floccia, Caroline

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**How much exposure to English is necessary for a bilingual toddler to perform like a monolingual peer in language tests?**

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Title: How much exposure to English is necessary for a bilingual toddler to perform like a monolingual peer in language tests?

Abstract

*Background:* Bilingual children have smaller vocabulary in each of their two languages than monolingual learning each of those languages and that bilingual children take a little longer to reach the same levels as monolinguals on various grammatical tasks. Early lexical assessment of referred bilingual children is a challenging process for speech and language professionals, to differentially diagnose between a language acquisition difficulty affecting language learning and a difficulty affecting the acquisition of an additional language through formal standardised test procedures of language development.

*Aims:* We investigated the usefulness of the amount of exposure to English when screening bilingual toddlers using standardised English language measures to identify whether a minimal cut-off point exists in a scale of exposure above which the bilingual toddlers would perform similarly to monolingual peers.

*Methods & Procedures:* Thirty-five bilingual 2½-year-olds exposed to British English and an Additional Language and thirty-six British monolingual toddlers were assessed on the auditory component of the Preschool Language Scale, British Picture Vocabulary Scale and an object-naming measure. All parents completed the Oxford Communicative Development Inventory (CDI) and an exposure questionnaire which calculated the proportion of English language input and gathered demographic data.

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*Results:* Hierarchical regression analyses carried out found English exposure to be the main predictor of performance of bilingual toddlers (marginal for auditory PLS 4), when age, birth order, gender, and SES (parent's occupation and education scores) were accounted for. Bilingual toddlers with English exposure of 60% or above performed like their monolingual peers in all measures. K-means cluster analyses and Levene variance tests performed on all language measures confirmed the estimated cut-off point which identified a group of similar language performance consisting of bilinguals with English exposure of 60% or above and monolingual toddlers and a group of bilingual toddlers with English exposure under 60%. Finally, the Additional Language (Arabic) production CDI scores were significantly inversely related to the amount of exposure to English.

*Conclusions & Implications:* These results suggest the language exposure questionnaire measure can become an important factor for the decision to test bilingual children on standardised monolingual tests. Thus, if a bilingual 2½-year-old is exposed to English more than 60% of the time; she/he may be screened using English-only monolingual norms.

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*What is known about this subject?*

Bilingual children have smaller vocabulary in each of their two languages than monolingual learning each of those languages and that bilingual children take a little longer to reach the same levels as monolinguals on various grammatical tasks. It also has been established that the relative amount of exposure to each language is strongly related to the children’s rate of development in those languages.

*What this paper adds*

The bilingual toddlers of this sample with English exposure of 60% or above performed like their monolingual peers in all language assessment measures. The proportion of exposure to English can become an important indicator when developing screening tests for use by speech and language professionals in the UK.

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## Introduction

It is now well-established that although bilingual children may have smaller vocabularies in each of their two languages than monolinguals learning each of those languages (Bialystok, 2009), and that bilingual children take a little longer to reach the same level as monolinguals on various grammatical tasks (cf. Gathercole, 2007), they make up for this in terms of advanced meta-linguistic awareness (cf. Bialystok, 2007) and the development of executive function (cf. Bialystok, 2009; but also Kovacs & Mehler, 2009; Poulin-Dubois, Blaye, Coutya, & Bialystok, 2011). However, amongst the general population in the UK the impression remains that one should expect bilingual children to be delayed – even quite dramatically delayed – in the early acquisition of language.

This is particularly problematic in the UK because of how early language development is screened as children neither have regular access to a paediatrician nor is preschool language development systematically screened. Rather each child is seen once at 12 months and once at around 2½ years by a ‘health visitor’, who is a Specialist Community Public Health Nurse within the Nursing and Midwifery Council trained to carry out and interpret a general assessment of motor, social and language development. In addition to the health visitor assessment, children are referred to Speech and Language Professionals (SLPs) if either their parents or their ‘nursery’ (i.e. kindergarten) teachers flag up issues with language development. Unfortunately in the UK, early years’ workers are not required to receive specific training in what to expect in language development from monolingual let alone bilingual children.

Concern has been expressed that bilingual children with delays or disorders relating to or including language development may be at risk of under-referral in the UK (e.g. Crutchley, 2000; Stow & Dodd, 2003). Under-referrals can occur for a variety of developmental disorders including pervasive disorders (ASD), sensory (hearing impairment) and also specific language impairment (SLI) which is language impairment that cannot be accounted for in terms of general

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intellectual disorder, hearing loss or environmental deprivation (e.g. Bishop, 2006). Recently, Crutchley (2000) found in parent interviews that a far larger proportion of the bilingual parents (45%) stated that professionals had initially failed to diagnose their child’s difficulties or take note of the parents’ worries than did the monolingual parents (18%). Under-referral would have potentially more serious consequences than over-referral since most professionals agree that early identification of at-risk children, even without an intervention (in a watch-and-see approach, see Paul, 1996), is a necessary step to prepare for an intervention (see also Ellis Weismer, 2000).

In principle the language development of all preschool children in the UK would be systematically screened by SLPs and for bilingual toddlers and pre-schoolers the official guidelines of the both the Royal College of Speech and Language Therapists (RCSLT, 2007) in the UK and by American Speech-Language-Hearing Association (ASHA, 1999) in the USA would be followed with the results that they would be screened in both of their languages (see also Pena & Halle, 2011). However, two real-world facts make this principle unreachable; firstly, even when bilingual toddlers are referred to SLPs in the UK, the official guidelines are usually not followed because assessment in the child’s ‘other’ language is challenging for a number of reasons which we will outline below. Secondly, bilingual pre-schoolers (particularly those of less educated and / or first-time parents) will remain subject to erroneous clinical decision not making it as far as referral if early years’ workers (health visitors and early year’s practitioners) in the UK are not provided with an easily applicable way to determine if a particular bilingual child is in need of referral.

The current study is an exploratory one which aims to lay the ground for further work determining whether indeed such a measure might be developed with which the early years’ worker is able, through discussion with the parent, to determine, firstly, the percentage of time the child hears English and secondly, the child’s performance on the British English version of the MacArthur-Bates Communicative Development Inventory or CDI (Fenson, Dale, Reznick,

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Thal, Bates, Hartung, et al., 2007). The key idea underlying this work is that ‘bilingual does not equal bilingual’. That is, for those children who are dominant in English, it might be appropriate for early years’ workers to screen children using monolingual norms on an instrument such as the CDI. Indeed the expected performance might be within the monolingual norms, with the implication that a given bilingual child who is a) dominant in English but b) performing significantly below the monolingual norms is in need of referral to SLPs. Given that the waiting list in the UK to see a SLP, even after referral, is up to 12 months in some regions, a move towards basic screening by non-SLPs professionals would seem a pragmatic move.

Before we move onto issues concerning the selection of a) an appropriate instrument to measure the proportion of the input which is English and b) a language screening measure which early years’ workers could easily use and interpret, we will first briefly review evidence that the assessment of bilingual pre-schoolers, not only in the UK, is problematic even for SLPs.

Firstly, SLPs are frequently faced with children for whom no standardised tests are available in their Additional Language. More problematically, even when standardised tests exist in the Additional Language, the monolingual norms of that Additional Language cannot be directly applied to bilingual children as they have been found to underperform monolinguals on these language tests (e.g. Hoff, Core, Place, Rumiche, Senor & Parra, 2012; Restrepo & Silverman, 2001 for Spanish in the USA). Even the suggestion to use conceptual vocabularies, i.e. the total number of semantic concepts for which a child has a lexical form, regardless of which language it is in, (Junker & Stockman, 2002; Pearson Fernandez & Holler, 1993) is unworkable. Thordardottir, Rothenberg, Rivard and Naves (2006), for example, found that the conceptual vocabulary of the bilingual group with balanced exposure to both languages was in fact significantly lower than the monolingual English group.

Working with an interpreter also has its pitfalls as translation styles may vary from the general to the literal word-for-word (Stow & Dodd, 2003) and result in data that are hard to



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interpret. Such informal, ad-hoc procedures would be considered unacceptable as the sole or main source of information on a child's language level for a monolingual child (Thordardottir et al., 2006). For this reason, one recent stream of thought puts a great deal of weight on asking the parents of bilingual children to assess how well they think their child is progressing. For instance, Paradis, Emmerzael and Duncan (2010) have developed a parental questionnaire with parents of children aged 4;9 – 9;0, which is designed for use with bilingual children from any language background along with guidelines for scoring in a clinical setting. However, it was found that some parents were unable to assess their children's sentence comprehension and did not even understand the questions pertaining to this.

One of the most promising methods is that of dynamic assessment, which is sometimes called 'response to intervention' or RTI (e.g. Gutiérrez-Clellen, & Pena, 2001). Among the various types of dynamic assessment, the most common one is test-teach-retest, where the difference between initial scores and later scores is compared, following an intervention interlude, thus revealing a particular child's capacity to learn. If a child initially performs significantly below the mean because of a reduced exposure to a language, his or her intact learning capacity should be revealed by a large difference in pre- and post-test scores (as compared to a child with a reduced language learning capacity). While this assessment method for bilingual children appears the most suitable, it has one critical drawback and that is the time and thus cost involved for the SLPs.

Probably in part because of the cost and time constraints that SLPs on the ground face, the reality of the procedures currently used to assess bilingual children in English-speaking countries is that the official recommendations are not strictly followed by professionals. Caesar and Kohler (2007) recently surveyed 409 SLPs in USA, and found that 130 of these had at least one bilingual child on their caseload (the age range being from mid-preschool years up to secondary school). While 63% of the respondents mentioned Spanish as one of the second languages they are faced

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with, they also listed 33 other languages. Only 48% mentioned using interpreters some of the time. Some mentioned taking language samples, but these were predominately samples of the children's spoken English and not of their Additional Language. The predominant method of assessing bilingual children was through formal standardised procedures and 75% said that English was the language of the test or procedure they used most frequently. The Peabody Picture Vocabulary Test (PPVT; Dunn & Dunn, 1997) and the Clinical Evaluation of Language Fundamentals 3 (CELF; Wiig, Secord & Semel, 1992) were the most frequently mentioned tests and only very few reported using the Spanish adaptation of the PPVT or any other test with norms in the child's Additional Language or with bilingual norms. In a recent review, Stow and Dodd (2003) painted a similar picture of referral and therapy for bilingual children in the UK.

A practical step would appear to be to establish a systematic language screening measure usable by early years' workers, who can then, if necessary, refer to SLPs. These would hopefully have reduced caseloads as a result of not having to carry out the initial screening process which would free up their time to implement intervention methods such as RTI.

The first step was to develop a questionnaire which estimates the percentage of time a bilingual child hears English. Because bilingual children do not hear and use each of their languages as often as monolingual peers who speak one language, and because bilingual children have different experiences with their two languages that could lead to different outcomes, the English language performance of bilingual children is related to the input of exposure to English. Recently, it has been established that the relative amount of exposure in each language is strongly related to the children's rate of development in those languages (Gathercole & Thomas, 2009; Hoff et al., 2012; Pearson, Fernández, Lewedeg, & Oller, 1997; Scheele, Leseman, & Mayo, 2010; Thordardottir, 2011). The documentation of amount of exposure was often described in terms of the languages spoken at home versus in the school. Recent attempts were made to calculate the English input of 2 year old children by gathering more detail, for example using a

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prospective Language Diary (De Houwer, 2009; Hoff et al., 2012; Parra, Hoff & Core, 2011; Place & Hoff, 2011). In this document, caregivers keep a log diary over a course of seven days which measures the percent of 30-minute periods when the child hears two language inputs, in a number of contexts and depending on the number of speakers. Thordardottir (2011) chose to calculate the relative amount of language exposure (in percentage) through a detailed questionnaire filled in by parents to assess the child exposure to each language in situation with potential communicative interactions, with data spanning on a continuum of bilingual exposure. In the same vein and autonomously, we compiled our own questionnaire to obtain the percentage of language exposure of each child. This questionnaire was filled out by the parent(s) in in conversation with the experimenter, it focused on a typical week and asked questions pertaining to (amongst other things) the number of hours a week in English-speaking nursery/childminder/playgroup, the number of hours per night spent sleeping, whether the mother (father) always/ usually / often / sometimes speaks the Additional Language, the number of hours per week spent with one parent only and whether the mother or father tends to speak more to the child when the whole family is together. This is outlined in more detail in the method section and Appendix 2. Parents were asked to report the number of hours they spend with their child rather than been asked to estimate the percentage of time their child hears English. Indeed people do not in keep detailed records of who is talking to the child in what language and in fact parents are rather poor estimators of their own efforts and abilities (see e.g. Kruger and Dunning, 1999).

Our second step was to include simultaneous bilingual toddlers of all language backgrounds, as long as one of their languages was English, as that is the situation which SLPs face in the UK, USA and Canada (e.g. Caesar & Kohler, 2007; Paradis et al., 2010; Stow & Dodd, 2003). Specifically for the UK, according to the Office for the National Statistics (ONS, 2011) the number of births have seen a marked rise over the last decade to non-UK born mothers in England and in Wales which accounted for 25.1 per cent of all live births in 2010, compared

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with 15.5 per cent in 2000 (this proportion has increased every year since 1990, when it was just under 12 per cent). Therefore, we restricted our focus to children aged between 28 and 32 months, which is the earliest age at which children are referred to speech therapy in most areas of the UK.

The third step was to establish which levels of English language development should be expected, given the proportion of time a given bilingual toddler hears English. Since our ultimate long-term goal is to be able to establish a level of English development using a basic screening instrument usable by early years' workers in consultation with parents, an ideal measure would have been a previously standardized British version of the American MacArthur-Bates Communicative Development Inventory (Fenson, et al., 2007) which not only asks parents about their child's vocabulary but also about their child's expressive morphology and multi-clause utterances. To date there is no standardized British version of this instrument. We therefore chose the Oxford CDI since results using this version had been published (Hamilton, Plunkett & Shafer, 2000). Whilst the Oxford CDI assesses both comprehension and production components, it does not include a section on the grammatical complexity of language production. Because this measure was not standardized, we decided for the purposes of validating its use with our population to simultaneously test the children using the British Picture Vocabulary Scale III, a direct measure of word comprehension, since the American equivalent (PPVT-III) was found to be one of the most frequently used instruments for diagnosis of bilingual children in the USA (Caesar & Kohler, 2007). This test is also one which early years' workers might also be taught to use themselves since it is very straightforward to carry out. We also tested the same children on the Preschool Language Scale or PLS 4 (PLS 4; Zimmerman, Steiner, Evatt Pond, 2009) as it is frequently used by SLPs in the UK and USA with this age-group.

An object naming task was included which was adapted from a sub-test on a standardised task for German-speaking two – three-year-olds (Grimm, 2000). Finally, we retrieved the CDI in

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the Additional Language whenever we were able to access the adaptation. The rationale for this was to examine whether there would be an (inverse) correlation between the vocabulary development in English and in the Additional Language, and importantly whether the amount of exposure to English would predict the vocabulary scores in both CDI versions.

Thus the current pilot study investigated whether the scores of UK bilingual children on a various production and comprehension measures could be predicted by the proportion of exposure to English as compared to the Additional Language experienced in interaction during a typical week. The crucial question was whether one could identify a minimal cut-off point in a scale above which bilingual children as a group would perform similarly to monolingual peers as a group, and over which at-risk children could be easily identified.

Finally, since the Oxford CDI and object-naming tests are not standardised for British monolingual children, we compared our sample of bilingual children with a sample of monolingual children with the same mean and range of age, gender ratio, parent occupational and educational level to first replicate previous findings that bilingual 2½ -year-olds will indeed differ from their monolingual peers on these tests, if tested on one language only.

Methods

*Participants*

Eighty-six children living in Plymouth, East Kent and the Birmingham area were recruited through the University databases of the Plymouth Baby Lab, Kent Child Development Unit and Birmingham Infant and Child Laboratory. The Ethics Committee boards of these institutions granted full approval for this research and the parents and children involved provided consent to participate in the study. Forty-two were native British monolingual English-speaking and 44 were simultaneous bilingual children born in the UK who were first generation of migrants. There were two sets of exclusion criteria. The first set, which was applied equally to

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both monolingual and bilingual children, resulted in the exclusion of eight children for the following reasons: 3 children because their parents reported that audiologists /SLPs had previously diagnosed them with either hearing impairments or a speech delay or because they were born prematurely; 2 children either did not cooperate or their parents intervened during the test; 3 children did not complete three or more assessment measures. The second set of exclusion criteria applied only to bilingual children and resulted in 4 children being excluded because their parents did not fill in the English exposure questionnaire and 3 bilingual children being excluded because their parents rated them with nearly 100% input in one language. If a parent reported that the child was exposed to three or more languages, the child was not included in the sample. The final sample comprised 36 British monolingual (21 girls) and 35 bilingual (17 girls) children whose age ranged between 28-32 months (for monolingual children:  $M = 30.47$ ,  $SD = 1.2$ ; and for bilinguals:  $M = 30.21$ ,  $SD = 1.2$ ). Most of the children were first (60%) or second (30%) born, whilst the remaining children were third (7%) or fourth (3%) born. Socio-economic status of families was calculated by educational achievement of each parent as well as by parental occupation rated on the 9-point scale proposed by Hollingshead (1975, as cited in Bornstein, Hahn, Suwalsky & Haynes, 2003). Information about family income was not requested, as this would be culturally extremely awkward in the UK. The educational level of the family was high (81%; i.e. degree and above) or middle (16%, i.e. completion of secondary school) status<sup>1</sup>. Information about occupational status appeared more discriminant as the scores ranged from 3 to 9 with a mean at 7.6 and this did not differ between the two groups. There was no difference between the bilingual and monolingual households in the distribution of mothers or fathers across the levels of occupational status and educational level ( $t(67) = 1.51$ ,  $p = .14$  and  $t(67) = 1.20$ ,  $p = .23$ , respectively).

Bilingual children were born and raised in England and were exposed to no more than two languages. Among the bilingual children, 20 had both parents speaking the same Additional

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Language to the child, 9 had only the father and 6 had only the mother speaking the Additional Language. The Additional Languages spoken were Arabic (13), French (3), Punjabi (2), Italian (2), Spanish (2), Catalan, German, Greek, Irish Gaelic, Dutch, Finnish, Polish, Albanian, Czech, Kurdish, Afrikaans, Swahili, and Mandarin.

*English Exposure Questionnaire*

We used a self-reported English exposure questionnaire (EQ) devised to obtain an objective estimate of the average proportion of the time a child hears English and the Additional Language during a typical week during the last year of the life of the child that did not involve holiday periods such as Christmas break (see Appendix 2). Section A identifies the number of language/s spoken at home<sup>2</sup> and accordingly directs to subsection B or C or D, which are similar with the exception of the initial question. Section B assesses bilingual children whose parents both speak another language at home (i.e. mother and father both speak Russian). Section C is addressed to the families in which one parent speaks English and the other parent speaks an Additional Language to the child. These sections ask questions about the average number of hours per week a child spends in an English speaking childcare environment (nursery, day care, preschool, child-minder, relative or friend) and the number of hours the child spends sleeping per 24 hours. Other questions ask how often the mother and the father talk to the child in English as opposed to the Additional Language when on their own with the child using a five-point ordinal scale (e.g. always, usually, half the time); who speaks more to the child when the two carers are together; and the number of hours per week that a child spends time with each parent singly. Based on this information, calculations (see the formulas and computations in Appendix 3) estimate the number of English-hearing hours per week. Scale responses (e.g. whether the mother speaks English to the child always, most of the time, half/half, rarely or never) are converted into weights (here, 100, 75, 50, 25 and 0%) which are used to recalculate the number of English hours. For example if the mother spends 10 hours a week on her own with her child, and speaks



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to her mostly in English, then these ten hours will become 7.5 hours of English and 2.5 hours of the Additional Language. The last section D is filled in by monolingual and bilingual parents and provides details of date and place of birth of the child, the highest qualification of the mother and father along with their current occupation, the length of time living in the UK and the presence and number of younger or older siblings. It also assesses any known developmental issues such as being born six or more weeks prematurely, hearing difficulties or more general developmental delays.

#### *Language skill tests*

*The British Picture Vocabulary Scale III (BPVS III, Dunn, Dunn and NFER, 2009).* The BPVS III is a receptive vocabulary test for Standard British English between 2 years 6 months and 16 years 11 months. It is the British version of the PPVT. Each item consists of four colour illustrations on a plate and the task of the children is to select the picture that illustrates the meaning of a word said by the test administrator. The test ends at the ceiling set that is established when a child made eight or more consecutive errors within a subset. The scores are calculated as the number of correct responses.

*Preschool Language Scale 4 (PLS 4; Zimmerman et al., 2009).* This test, which covers a range of English language skills normed for monolingual children between birth and 6 years, is designed to identify children with language disorder. The PLS 4 consists of two components, an auditory and a production component. The auditory component contains sentence processing and items on syntax items as well as some vocabulary items. In piloting we found that the production component of the PLS was too lengthy as it asks the tester to do things like 'wait until the child spontaneously produces a subject together with a verb'. The scores were calculated by subtracting the number of failed items from the last numbered task that was the ceiling item.

*Object naming sub-task (adapted English SETK-2).* The language test Sprachentwicklungstest-2 (SETK-2, Grimm, 2000) was originally designed and standardised in



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German to measure receptive and expressive language skills in 24-36 months-old German children, and is divided into four sub-tests, of which we only used the object naming sub-task (see appendix 1 for the English translation)<sup>3</sup>. This object-naming task consists of 30 items, of which the first six are actual objects. The latter were matched to the original items in the German version. The remaining 24 items are colour pictures, which were photocopied from the German test, except the item ‘petrol station’ which was replaced as it did not look like an English petrol station. For each item, the children were asked ‘What’s this?’ and were given a score of 1 if the child offered any of the English words given as options for that item (appendix 1). If the child gave a response which was not on the list (e.g. ‘egg’ for ball or ‘apple’ for ‘pear’) or in the other language, this was scored as 0.

*Oxford Communicative Development Inventory (Oxford CDI, Hamilton et al., 2000).* This parental report measures the assessment of English comprehension and production of 416 early words. For the assessment of the vocabulary size of the Additional Language, where available, a version of the Additional Language CDI-instrument was handed to the parent. These included the Arabic (Safi, Dashash, & Ba-Saffar, in progress, personal communication), French (Kern, 2007), Italian (Caselli & Casadio, 1995), Spanish (López Ornat, Gallego, Gallo, Karousou, Mariscal & Martínez, 2005), Catalan (Serrat Sellabona, in progress, personal communication), German (Szagun Stumper, & Schramm, 2009), Gaelic Irish (O’Toole & Fletcher, 2010), Dutch (Zink & Lejaegere, 2002), Finnish (Lyytinen, 1999), Polish (Smoczynska, in progress, personal communication), Slovak (Kapalková, Slančová, Bónová, Kesselová, & Mikulajová, 2010)<sup>4</sup>, and Mandarin (Tardif, Fletcher, Zhang, Liang, & Zuo, 2008) languages. For the two Punjabi bilingual children, the Punjabi-English bilingual tester translated the Oxford CDI into Punjabi<sup>5</sup>.

*Procedure*

Almost all children were seen twice by monolingual British English-speaking research assistants with no more than ten days between the two visits. Prior to the first visit, all parents

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were sent the Oxford CDI (and the CDI in the Additional Language when available) to be filled in at home and asked to observe their child for a few days. During the first visit the children were assessed on the PLS 4 Auditory Comprehension test. During the second visit, the parents returned the Oxford CDI and the self-reported Exposure Questionnaire (which was discussed with the parent on the day of the testing), whilst the children were assessed on the BPVS III and English SETK-2. Each testing session lasted 30 minutes, and if testing was not completed during this time, the parent and child returned for a third visit.

### Results

Table 1 presents the mean values and standard deviations of the bilingual and monolingual groups in terms of demographic data (age, gender, birth rank, parental occupation and education) and language assessment measures (BPVS III, PLS 4, English SETK-2, Oxford CDI). Raw scores were obtained as measures for the BPVS III, PLS 4, and English SETK-2, and transformed into z-scores for all analyses (although for clarity, some figures and tables are presented with raw scores). Standardised normative scores were not used for the BPVS III and PLS 4 since the normative data for BPVS III start from 36 months which is above the age of our children. On the PLS 4 our children fell right in between the age bands for the standardised norms, which in this test are grouped separately for 24-29 and 30-35 months. Therefore, if normative scores were used the youngest children would achieve higher scores than our oldest children.

Finally, for the CDIs Comprehension and Production in English and the Additional Languages, percentage scores were used, mainly because it was not possible to transform the scores on the CDIs in the Additional Language into z scores due to the small sample in each particular Additional Language and also because of the variability in the total number of items for each language (see below for discussion).

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*Comparison between monolingual and bilingual children*

Before we discuss the main analyses which look at the English language development of bilinguals as a function of the proportion of English in the input, we first present global comparisons between the monolingual control group and the bilingual children with all input levels conflated. Independent two-sample t-tests were conducted to compare the scores of the English monolingual and bilingual children on the English receptive and expressive language assessments (with equal variances not assumed; we shall come back on this later in the analyses). As can be seen in Table 1, bilingual children’s receptive vocabularies in English as assessed by the BPVS III were on average significantly lower than those of the monolingual children,  $t(56.4) = 3.94, p < .001$ ; mean diff. = .89, Cohen’s  $d = .98$ . Similarly, the expressive vocabulary scores as assessed by the English SETK-2 were significantly lower for the bilingual group as a whole than for the monolingual controls,  $t(33.4) = 4.36, p < .001$ ; mean diff. = 1.0,  $d = 1.12$ . Both the Oxford CDI comprehension and production scores were also significantly lower for the bilingual children than for the monolingual children,  $t(35.3) = 3.93, p < .001$ ; mean diff. = 86.82,  $d = .95$  and  $t(42.0) = 5.36, p < .001$ ; mean diff. = 130.1,  $d = 1.30$ , for word comprehension and production respectively. Finally, for the PLS 4 test, which assesses English comprehension, the bilingual children scored on average lower than the monolingual children but this difference was not significant,  $t(40.9) = 1.29, p = .2$ ; mean diff. = 0.37).

Our findings that as a group, bilingual children scored lower than monolinguals in terms of lexical knowledge, when assessed on one of their languages, is not surprising and fits with the previous literature (e.g. Junker & Stockman, 2002; Hoff et al., 2012; Gathercole, 2002; Thordardottir et al., 2006). Furthermore on all measures, bilingual toddlers displayed higher

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variances than monolingual ones. This would be expected from a participants' sample whose language development depends from additional characteristics as compared to monolinguals (including, as we will see, the amount of exposure to each language). In addition, for some measures (Oxford CDI comprehension and SETK-2), some monolingual toddlers might have reached the ceiling levels, as reflected not only in the high scores but also on the lower associated variance as compared to bilinguals.

A more interesting question, however, was the degree to which their performance depends on the proportion of their English input. Therefore the following analyses focussed on the bilingual children, for whom it was examined how the amount of English exposure would predict the scores on the language assessment tests, once corrected for the effect of demographic variables such as gender, age, birth order and SES.

#### *Bilingual children*

##### *Relationship between English vocabulary skills, demographic variables and English exposure*

Bilingual children spanned the full range of the proportion of English in the input which can be found amongst bilingual toddlers in modern Britain; that is the proportion of English in their input ranged between 5% and 98% in a typical week during the last year of the life of the child ( $M = 58.23$ ;  $SD = 26.67$ ).

Hierarchical regression analyses were carried out for each language measure to determine whether English exposure could be used to predict the vocabulary skills of bilingual children, after accounting for demographic data<sup>6</sup>. In the first block, predictor variables comprised the age in months, birth rank in the family, gender of child, parent's education and occupation scores. In the second block, percentage of exposure to English was introduced. Table 2 displays the percentage of variance explained in each block for each language measure together with the parameters of the regression equations.

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For the regression analyses performed on the language comprehension/auditory measures tests (BPVS III, PLS 4 and CDI Comprehension), the demographic measures did not account for a significant proportion of variance, but in the second block the proportion of English exposure was a significant predictor (marginal for PLS 4 though; see Table 2 and also Figure 1) and explained a significant amount of variance (an additional 24.1% for the BPVS III, 11.6% for the PLS 4, and 26.4% for the CDI Comprehension). The regression analyses for the two tests of lexical production (the English SETK-2 and the Oxford CDI Production) both revealed a significant impact of demographic variables in the first block (43.2% variance explained for the SETK-2 and 36% for the CDI Production), mainly due to the variable age (SETK-2: standardised  $\beta = .47$ ,  $t(22) = 2.84$ ,  $p = .009$ ; CDI Production: standardised  $\beta = .51$ ,  $t(26) = 3.13$ ,  $p = .004$ ). In the second block, the proportion of exposure to English significantly explained an additional 15.9% (SETK-2) and 30.4% (CDI Production) of the variance.

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Insert Table 2 and Figure 1 here  
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*Identifying the percentage amount of English exposure needed to perform within a monolingual range*

In summary so far, the proportion of English in the language input to a bilingual 2½ - year-old predicts his or her performance in the five English assessment measures used in this study (marginally in the case of the PLS 4), once demographic data including age, birth order, gender, and parent’s occupation and education scores have been account for. This brings us to the crucial application of our study for early years’ workers in the UK; to the question of whether there is a cut-off point in terms of the proportion of a child’s input that is English where an early years’ worker can treat that child as monolingual for purposes of screening for referral; and if

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yes, what is the percentage of exposure to English above which bilingual children achieve similar scores to monolingual children?

In order to determine this, a two-stage cluster analysis as recommended by Milligan and Sokol (1980; see also Punj & Stewart, 1983) was performed, to obtain a first approximation of the data grouping via a hierarchical cluster analysis, which is then refined by a k-means analysis (see Steinley, 2006, for a review of k-means cluster analyses methods). For the initial hierarchical cluster analysis Ward's minimum variance method was used (Ward, 1963), together with squared Euclidian distance as the similarity measure for each language assessment test (BPVS III, English SETK-2, Oxford CDI comprehension and Oxford CDI production). Each child's score (z-score or raw score depending on the measure, see above) was entered without the information about his/her linguistic background (monolingual or bilingual) and for bilingual toddlers, without the information about their amount of exposure to English. This was followed by a K-means cluster analysis to optimise the results.

From the hierarchical cluster analyses, dendograms for each of the four measures show that a 2-clusters solution divides the entire population in two groups. For example for the BPVS III, 19 participants were assigned to Cluster 1 and 46 to Cluster 2. Out of the 19 assigned to Cluster 1, 14 were bilinguals and 5 monolinguals (with low scores on the BPVS III). Cluster 2 was made of 29 monolinguals and 17 bilinguals (with high scores on the BPVS III). Inspection of the amount of exposure of bilinguals (N=31) assigned to Cluster 1 or 2 shows that most of those with less than 60% exposure to English were found in Cluster 1 (12 children out of 15) and most of those with more than 60% of English were found in Cluster 2 (14 out of 16). Then the k-means cluster analysis (see Table 3) confirmed and refined this result by assigning 12 bilinguals with exposure under 60%, 2 bilinguals with exposure above 60% and 6 monolinguals to Cluster 1, while Cluster 2 was made of 3 bilinguals with exposure under 60%, 14 bilinguals with exposure above 60% and 28 monolinguals. Table 3 clearly illustrates that for each language assessment

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measure, the cluster solution divides children into two groups: most monolinguals and the bilinguals with more than 60% exposure to English on one group, and most bilinguals with less than 60% exposure to English on the other group.

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Insert Table 3 here

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Further analyses were run to corroborate this first classification of children’s scores in two broad categories. First, the bilingual children were ranked according to their amount of English exposure from 5 to 98%. Then we performed independent-samples t-test with unequal variance assumed<sup>7</sup>, between the 35 bilingual children and the 36 monolingual children on each of the following tests: BPVS III, English SETK-2, Oxford CDI Comprehension and Oxford CDI Production<sup>8</sup>. The two groups of children systematically differed on these tests. Then, the bilingual child with the lowest amount of exposure (5%) was removed and the analysis was re-run. Again the monolingual and the bilingual scores were significantly different. The bilingual child with increasingly high amount of exposure was progressively removed until there was no longer any significant difference between the bilingual and the monolingual groups. This was reached when bilingual children with exposure above 54% were compared to the monolinguals for the BPVS III measure, above 58% for the English SETK-2, above 53% for the Oxford CDI Comprehension and above 62% for the Oxford CDI Production<sup>9</sup>. In other words, a bilingual child with a percentage of exposure to English at 60% (as a rounded cut-off point) is very likely to score similarly to a monolingual child on all four measures, whereas a child exposed to English less than 60% of the time is likely to score less than a monolingual child on the four standardised tests.

As a subsequent step, data Table 4 are included to provide an illustration of the ranked individual bilingual and monolingual child on the different measures (percentage of English



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exposure, PLS 4 Auditory, BPVS III, English SETK-2, Oxford CDI Comprehension and Production) and we have highlighted in light grey all the values that fall under 1 SD and in dark grey the values that fall under 2 SD below the average of the monolingual children for that measure. As can be seen, outliers are found randomly across monolinguals and bilinguals with an exposure above 60%, but are much more common for bilinguals with exposure under 60%.

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Insert Table 4 here  
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An interesting additional point is that the analysis of variability, when comparing the 18 bilinguals with less than 60% exposure to English to the 17 with 60% or above, was higher in bilingual children with less 60% exposure to English than in children with 60% or above (see Table 4 and Figure 1), suggesting a higher homogeneity of children's performances with higher English exposure. Levene tests confirmed that variance in children's performances with 60% exposure or above was lower than in bilinguals with less amount of exposure to English for the CDI Comprehension ( $F(1, 32) = 33.55, p < .001$ ), the CDI Production ( $F(1, 32) = 6.86, p = .01$ ), and marginal for the English SETK-2 ( $F(1, 28) = 3.87, p = .059$ ). Thus, it would appear that beyond a critical amount of input in a particular language, the vast majority of children have the ability to acquire that language in a relatively similar way.

Finally, it was also verified that the distribution of scores in the bilingual children with English exposure above 60% was similar to that of the monolingual children in terms of variance with the Levene tests to compare the two groups for each language measure. Levene tests was non-significant for all measures, with  $F$  values below 1 for the BPVS III, the CDI Comprehension and Production and the PLS 4, and  $F$  value slightly higher for the English SETK-2 ( $F(1, 47) = 2.37, p = .13$ ). This confirms that the variance was similar in monolinguals and bilinguals with exposure above 60% for all measures.



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*The Additional Language CDI-instrument*

Up to this point we have only examined the English abilities of the bilingual children. However, the parents of 29 of the 35 bilingual children also completed a version of the CDI in the AL which had been adapted, or was in the process of being adapted or (in the case of Punjabi) translated for the purposes of this study. As the proportion of English in the children’s input was the main predictor variable for the total expressive vocabulary of the Oxford CDI, we investigated if the inverse pattern would be found for the Additional Language CDI (see also Pearson, et al., 1997).

Although the bivariate Pearson correlation analysis carried out on the production score as a percentage of the total number of words in each Additional Language CDI of bilingual children did show a trend towards a linear negative relationship with the English exposure,  $r = -.27$ ,  $p = .15$ , (see Figure 2), this was not significant (a hierarchical regression analysis as above shows that the amount of exposure explains an additional amount of variance when introduced after demographical data, but not significantly so). One reason for this might be the unfortunate diversity across CDI adaptations in terms of the number of words included, meaning that some CDIs tested a broader range of vocabulary including less frequent words than others, leading to variation in exposure percentages and making the cross-linguistic comparison difficult. To illustrate, whereas the Mandarin version contains a broad sample of vocabulary of 767 words, the Arabic version contains only 416, i.e. almost half the words.

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Insert Figure 2 here  
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We then focused on the 13 Arabic-English bilingual participants, a population which is more highly represented in our sample, and looked at the correlation between the amount of

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English exposure and their score in the Arabic CDI. Although the norms for monolingual Arabic speakers do not yet exist for the Arabic CDI and although we are aware that there exists a variety of Arabic dialects, at least all our Arabic-English participants were assessed with the same tool, so any trend on one direction or the other is meaningful. Once corrected for demographic data i.e. age, birth order, gender, and parental education and occupation scores, the amount of exposure explained an additional 40.7% of the variance ( $F(1, 6) = 6.62, p = .042$  and the Arabic CDI scores were significantly inversely related to the amount of exposure to English (standardised  $\beta = -0.87$ ).

### Discussion

The current study investigated whether the scores of a sample of UK bilingual toddlers on our various production and comprehension measures could be predicted by the proportion of exposure to English as compared to the Additional Language experienced in interaction during a typical week. The crucial question we wished to explore was whether one could identify a cut-off point above which bilingual toddlers as a group would perform similarly to monolinguals as a group, and over which at-risk toddlers could be easily identified. Our long-term goal underlying this pilot study is to develop a screening method of bilingual two-year-olds which could be carried out by early years' workers in consultation with parents. The ideal measure for this would be a standardised British version of the CDI in conjunction with an objective measure of the proportion of the toddler's input which is English.

Since the MacArthur-Bates CDI is not standardised in the UK, we firstly assessed 35 bilingual 28-32 month-olds on the Oxford CDI and 36 matched monolinguals and, secondly, assessed both groups on two measures standardised for monolinguals (BPVS III and PLS 4) as well as an object-naming test (English SETK-2). When possible we also assessed the bilingual toddlers on the Additional Language CDI, even though this may or may not be available to early years' workers, dependent on the child's Additional Language. We indeed found in hierarchical

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regression analyses that the proportion of English in the input was the strongest (and for comprehension the only) predictor of the performance of bilingual toddlers on the CDI for both lexical comprehension and production and accounted for 11-26% of the variance. Moreover, two-stage cluster analyses suggested a 60% English input (exposure as measured by our questionnaire) cut-off point at which the bilingual toddlers performed like their matched monolingual control group. Thus, for the CDI comprehension all of the monolinguals and all the bilinguals for whom English composed 60% or more of their input fell into one cluster, whereas half the bilinguals for whom English composed less than 60% of their input fell into another cluster. This conclusion is further supported by the fact that not only did the proportion of English in the input predict performance of the same toddlers on the BPVS III and the English SETK-2, but also that the input proportion cut-off point for these other two tests was highly similar to that for the CDI. This finding indicates a great deal of promise for the further development of a standardised screening instrument for early years' workers in the UK (and perhaps also other English-speaking nations). Whilst the cluster analyses identified two distinct groupings at 60% in all four measures, the iterative t-test identified an amount of English input 53-54% for the two comprehension measures that is necessary to perform like monolingual toddlers and higher input levels 58-64% exposure for the two production measures. Overall, these findings are not distant with the data obtained with older children by Thordardottir (2011) where critical levels were suggested at 40-60% exposure or more in receptive vocabulary and exposure in excess of 60% in expressive vocabulary to score similarly to monolingual children. The studies are different in that their bilingual children were balanced in terms of the minority/majority language status (English/French official languages in Canada), language vicinity and that the children were older (5 year-old) and therefore had more time to learn the two languages. However, the two studies converge in identifying the same percentage for the expressive vocabulary and close percentage for the amount of receptive vocabulary.

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Which theoretical views can account for the findings that the amount of exposure predicts language development in the bilingual child's two languages? Bilingual toddlers have fewer opportunities relative to their monolingual peers to hear multiple tokens of the same word in one given language, which would allow them to build up a robust lexical entry. In the case of bilinguals, the amount of exposure to the two languages has a direct influence on receptive and expressive vocabularies. However, the amount of exposure seems to have a catastrophic effect rather than a linear effect on the process of language acquisition, the term catastrophic here being taken in its mathematical meaning. That is, when the Additional language is the minority language of the community and when exposure to English is somewhat larger than that to the Additional Language, acquisition of English seems to be achieved as best as it can be (meaning, comparable to that of a typically developing monolingual). Genesee, Paradis and Crago (2004) noted that the language for which children have received the greatest amount of exposure usually becomes their dominant language. The cut-off of 60% suggested by our data, and above which bilingual children seem to acquire English as their monolingual counterparts, could correspond to the value which determines their dominant language (at this point in time: language dominance can vary with changes of exposure, see Kohnert, 2004). In addition to providing some quantification of the amount of exposure necessary for one language to become dominant, our data also suggest a strong view of dominance, in which performance in the dominant language becomes less distinguishable from that of a monolingual child. That is, a child who is exposed to English above 60% of the time is enabled to acquire a lexical competence in English equal to that of a monolingual child, as measured by the four tests, plus a lexical competence in the Additional Language which is more unpredictable. There are, however, a number of points which deserve further discussion. On the PLS 4 Auditory component, the only test which assessed the comprehension of mixed processing skills of vocabulary and sentences, bilingual toddlers as a whole group could not be distinguished significantly from their monolingual peers, although

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marginal significance was found for the regression analysis of the relationship between proportion of English in the input and performance on the PLS 4. However, the majority of the bilingual toddlers did not complete the PLS 4 and those which did complete it predominantly heard English more than 60% of the time. Therefore, a future large-scale follow-up study would need to ensure that a large number of bilingual two-year-olds, including those who heard the Additional English the majority of the time, completed this or a similar standardised measure of sentence processing.

The second issue in this study concerns the omission of measure of productive syntax. The original intention was to pilot a measure which early years' workers could easily be trained to carry out and we thought this would be unlikely for measures such as the analysis of language samples or carrying out the expressive component of the PLS 4. On reflection, for a larger scale follow-up we would prefer to use the Lincoln-UK version of the Toddler CDI, although unstandardized, as it is closer to the original USA MacArthur-Bates CDI in also having measures of morphology and syntax (or at least multi-word speech). That said, almost all primary-school aged SLI children score at least 1 SD below the mean on vocabulary measures (Conti-Ramsden, Crutchley & Botting, 1997), no matter which 'sub-group' of the disorder they fall under. Secondly, almost all children with SLI have a history of initial language delay, which manifests itself in delayed and protracted receptive and expressive lexical acquisition. Although not all toddlers with delayed vocabulary development later receive a diagnosis of SLI, Dale, Price, Bishop and Plomin (2003) found that normally-developing 2-year-olds who scored below the 10th percentile on the MacArthur-Bates Short Form CDI in production were significantly more likely to fall into the category of language-impairment in the 3- and 4-year-old age-range. Only a tiny proportion of the 6500+ children who scored above the 10th percentile for vocabulary production at two years went on to have difficulties in grammatical development at 3 and 4 years of age. Thirdly, grammatical development has been found to be highly intercorrelated with

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lexical development not only in normally-developing monolingual children but also in normally-developing bilingual children, possibly caused by underlying general maturational processes.

That is, a Spanish-English bilingual child's grammatical development in Spanish is predicted by his or her lexical development in Spanish (and not by his or her lexical development in English) and vice versa (Conboy & Thal, 2006; Marchman, Martinez-Sussman & Dale, 2004). Thus, we do not consider measurement of lexical comprehension and production to be at all irrelevant in an initial screening of two-year-old bilinguals who may have a language, hearing or other developmental disorder.

A third issue concerns the validity of our input questionnaire. Clearly there are a number of observations that one could make of our instrument. One might argue that detailed diary data collected by the parent on when and how much a particular language is spoken (see e.g. Hoff et al., 2012; Place & Hoff, 2011; but see also Paradis, 2010 with older children) might lead to a more accurate estimation of the proportion of English in the input although (see e.g. Schwarz, Bless, Bohner, Harlacher & Kellenbenz, 1991: there is suggestion that humans are poor at indicating the frequency with which they carry out certain actions). One might also quibble with the fact that our measure gives more weight to maternal than to paternal input; the quality of English input was evaluated by assigning more weight to the mothers relative to the fathers (2/3 versus 1/3) given the same amount of time spent alone with their child. This was done because it has been found that generally fathers produce less verbal output than mothers to their child and they spend a greater proportion of their time interacting with their children in play activities, and that their play is more physical than that of mothers, therefore directly impacting on the amount of exposure in English and the Additional Language (e.g. Pancsofar & Vernon-Feagans, 2006).

Furthermore one might argue that our measure did not evaluate the quality of English input of the non-English parent to the child (if any), the type of language spoken between the parents in presence of the child, how much the parents talk to English friends or the amount of

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time spent on watching television in English versus the other language. Also, the potential co-occurring intra-sentential mixing or mixed language input within the same speaker should ideally be explicitly measured to disentangle its frequency and its effects from those of co-occurring dual language input. However, any problematic issues with our input questionnaire instrument would be likely to lead to insignificant relationships between it and the Oxford CDI, BPVS III, English SETK-2 and the PLS 4. Yet, the data from our questionnaire accounted for a significant amount of variance in all the tests we used. Thus, the fact that for the proportion of English input was a significant predictor for all the regression analyses (although marginal for the PLS) indicates that our instrument was at least roughly estimating the proportion of English in the input. Therefore, whether in future development of the screening instrument for early years' workers one uses our input questionnaire or an alternative, at the very least our instrument indicates future development as a potential way forward for screening bilingual toddlers living in Britain and in the cognate English speaking countries (USA, Canada, Australia, New Zealand and South Africa). It may provide useful suggestions for new adapted versions conveniently translated for bilingual children living in non-English speaking countries.

An additional issue of our screening method is that it does not provide a direct solution for those bilingual toddlers for whom English does not compose 60% or more of their input. While we did ask parents to complete the CDI in the additional language, where this CDI was available, overall, there was not a significant relationship between input and the Additional Language. This was mainly due to the variability created by the use of CDIs from different languages which had a large degree of variability in the total word scores. When we only look at a sample of Arabic toddlers who were all assessed with the same CDI tool in Arabic, a significant negative relationship did indeed emerge. Thus one tentative suggestion emerging from our study is to develop the use – where possible – of the CDIs which have been standardised for the Additional Languages. In fact, in personal communication, we have heard that SLPs in various



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regions of the UK are asking interpreters to translate the USA MacArthur CDIs. This practice could clearly be improved by the provision of those CDIs which are already available.

Finally, the most burning issue concerns whether 60% should be proposed as the cut-off point at which one should expect a bilingual to perform like a monolingual on tests standardised for monolingual English 2½ -year-olds. Clearly, if an alternative estimate of the proportion of English in the input were used, then one would probably not end up with 60% as some kind of magical number. However, the conclusion would still hold that bilingual toddlers who are dominant in English can be assessed in English only and thus need to be referred if their English test scores are 1.5 – 2 SD below the monolingual means.

Future investigation is needed with a wider sample of young children assessed longitudinally with individual amount of dual language exposure. Nonetheless these indications arising for the current study should have potential positive implications for reducing assessment time, waiting list time and assessment accuracy for bilingual children since in principle early years' workers could screen in English approximately half of the bilingual children, i.e. those who are above 60% on English exposure. While the other half (those scoring under 60%) would also require an assessment in the Additional Language, in a large number of cases, the CDI in the Additional Language could (and should) be available on-line as an assessment tool. Once a child at-risk for language delay is referred to a Speech and Language Therapist, more in-depth follow-up assessments will be carried (and e.g. response-to-intervention) to determine the existence and nature thereof a particular disorder.

Finally we come to the issue of the heterogeneity of Additional Languages included in the current study. This could be seen as a weakness in the field of developmental bilingualism as there are different degrees of linguistic proximity to the English language, and of social prestige of the Additional Language, depending on how it is integrated within the society (e.g. Welsh in Wales as compared to Punjabi in Plymouth). However, we hold that it is in fact a strength of the



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current study, firstly because early years' workers in the UK do not usually see bilingual toddlers learning one particular Additional Language. Rather, they encounter a multitude of different Additional Languages. Secondly, any variability that this heterogeneity causes should lead to weaker relationships between English input and performance on language tests. Thus, the fact that we found significant relationships is a point in favour of our approach.

We would argue that it is counterproductive to restrict the comparative study to one particular homogeneous Additional Language versus English language, particularly if this produces an extremely large number of dual language comparisons resulting from the thousands of languages spoken in the world (Katzner, 2002). Indeed, it does seem possible to consider the child as an English learner with a particular amount of exposure. Furthermore, our work suggests that the data collected from children with one homogeneous Additional Language pattern in the same way as data from children with a variety of Additional Languages. Overall, this approach gives hope to open the road to a new way of thinking about the early screening of bilingual two-year-olds. For two-year-olds who are dominant in one of their two languages, assessment in one language only and with simple tools seems possible. This could allow early years' workers to make an early evaluation regarding a child's language at 30 months of age, allowing those who need it to be referred early and freeing up the waiting lists from those who are not in need of referral.

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### Tables

Table 1. Mean values of demographic data and mean raw scores values and z-scores values, when appropriate, for the BPVS III, auditory PLS 4, English SETK-2, Oxford CDI word comprehension and word production scores of English monolingual and bilingual children (standard deviations are given in parentheses). Parents' occupation is provided on a scale from 1 to 9 following Hollingshead (1975, as cited by Bornstein, Hahn, Suwalsky & Haynes, 2003) and parental education on 3 values between 1 and 3. Missing values are due to unavailable data (parents failing to provide a questionnaire or child refusing to participate).

	<i>Monolingual</i>			<i>Bilingual</i>		
	<b>Raw scores (SD)</b>	<b>z-scores (SD)</b>	<b>N</b>	<b>Raw scores (SD)</b>	<b>z-scores (SD)</b>	<b>N</b>
<b>Age (months)</b>	30.21 (1.16)		36	30.21 (1.16)		35
<b>Proportion of girls</b>	58.3%		35	48.6%		36
<b>Birth rank</b>	1.36 (0.59)		34	1.71 (0.87)		36
<b>Parent's occupation</b>	7.86 (1.26)		34	7.35 (1.49)		35
<b>Parents' education</b>	2.71 (0.46)		34	2.85 (0.50)		35
<b>BPVS III</b>	37.68 (9.88)	0.42 (0.78)	34	26.45 (12.76)	-0.47 (1.03)	31
<b>PLS 4 Auditory</b>	41.19 (6.02)	0.15 (0.96)	31	38.90 (6.48)	-0.21 (1.03)	21
<b>English SETK-2</b>	25.70 (2.48)	0.48 (0.35)	33	18.63 (8.54)	-0.52 (1.21)	30
<b>Oxford CDI Comprehension</b>	399.29 (24.20)		35	312.47 (126.67)		34
<b>Oxford CDI Production</b>	372.71 (50.26)		35	242.62 (132.69)		34

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Table 2. Summary of the hierarchical regression analyses for the BPVSIII, PLS 4 Auditory, English SETK-2, Oxford CDI word comprehension and word production scores of bilingual children. For each block of variables entered in the regression and for each measure, value of the  $\beta$  coefficient with the p-value for the associated t-test. For each block the resulting  $R^2$  with its F value and level of significance is also provided. P-values more than 0.10 are reported as ns (non-significant) and values  $\leq$  to 0.05 are in bold.

		BPVSIII Coef. (SE Coef)	p	PLS 4 Coef. (SE Coef)	p	SETK-2 Coef. (SE Coef)	p	CDI Comp Coef. (SE Coef)	p	CDI Prod Coef. (SE Coef)	p
Block 1	Age	0.34 (0.41)	<b>0.04</b>	0.27 (0.31)	ns	0.47 (0.47)	<b>0.009</b>	29.23 (0.27)	ns	56.86 (0.51)	<b>0.004</b>
	Birth rank	-0.18 (-0.15)	ns	-0.05 (-0.03)	ns	-0.44 (-0.31)	0.065	-17.85 (-0.12)	ns	-39.21 (-0.25)	ns
	Gender	-0.17 (-0.08)	ns	0.16 (0.08)	ns	0.04 (0.02)	ns	2.54 (0.01)	ns	-42.27 (-0.16)	ns
	Education	-0.13 (-0.06)	ns	0.53 (0.25)	ns	0.32 (0.14)	ns	46.81 (0.22)	ns	14.32 (0.06)	ns
	Occupation	0.14 (0.19)	ns	0.22 (0.41)	ns	0.17 (0.22)	ns	-0.37 (-0.004)	ns	13.95 (0.16)	ns
	$R^2$	0.207		0.482		0.431		0.154		0.36	
	F	F(5,30) = 1.31	ns	F(5, 19) = 2.61	0.072	F(5, 28) = 3.49	<b>0.017</b>	F(5, 32) < 1	ns	F(5, 32) = 3.04	<b>0.026</b>
Block 2	Age	0.25 (0.31)	0.07	0.29 (0.34)	0.09	0.37 (0.37)	<b>0.019</b>	18.56 (0.17)	ns	45.09 (0.40)	<b>0.003</b>
	Birth rank	-0.05 (-0.04)	ns	0.02 (0.01)	ns	-0.27 (-0.19)	ns	9.01 (0.06)	ns	-9.49 (-0.06)	ns
	Gender	-0.32 (-0.15)	ns	0.19 (0.09)	ns	0.03 (0.01)	ns	-9.47 (-0.04)	ns	-55.56 (-.21)	0.082
	Education	-0.41 (-0.20)	ns	-0.15 (-0.07)	ns	-0.02 (-0.01)	ns	18.15 (0.07)	ns	-28.46 (-0.11)	ns
	Occupation	0.01 (0.02)	ns	0.27 (0.50)	0.09	0.11 (0.15)	ns	-6.71 (-0.08)	ns	6.94 (0.08)	ns
	Exposure	0.02 (0.57)	<b>0.003</b>	0.02 (0.43)	0.07	0.02 (0.47)	<b>0.008</b>	2.79 (0.59)	<b>0.002</b>	3.09 (0.63)	<b>&lt;.0001</b>
	$R^2$	0.448		0.598		0.591		0.418		0.664	
	F	F(6, 30) = 3.25	<b>0.018</b>	F(6, 19) = 3.23	<b>0.036</b>	F(6, 28) = 5.29	<b>0.002</b>	F(6, 32) = 3.11	<b>0.02</b>	F(6, 32) = 8.55	<b>&lt;.0001</b>

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Table 3. Individual raw scores of all children (bilingual and monolingual) assessed in the five English assessment measures, ranked as a function of their amount of exposure to English (from 5% to 100%). The score for the Additional Language CDI production is expressed as a percentage of the total amount of words for that particular CDI. Pale grey cells correspond to values which are under 1 SD below the mean of the monolinguals for this measure. Highlighted in dark grey cells are values under 2 SD from the monolingual values. For example, the average score of the monolinguals for the BPVS III is 37.7, with a SD 9.88. Therefore all outliers scores smaller than 27.8 are coloured in pale grey in this column, and those smaller than 17.9 are in dark grey. The black row marks the limit of 60% of English exposure above which bilingual children are not distinguishable from monolingual children.

	English exposure in %	PLS 4 Auditory	BPVS III	English SETK-2	CDI Comprehension	CDI Production	Other CDI Production
1	5		9	1	133	44	56.7
2	7	28	38	14	317	214	
3	14	36			413	210	25.4
4	21		3		0	0	69.7
5	27		21		65	31	45.4
6	31		18		301	297	9.6
7	33		18	9	181	80	37
8	34		4	12	63	45	8.2
9	37		25	19	416	252	32.9
10	37		38	23	264	212	21.4
11	40		4	10	58	1	5.8
12	44	35	17	7	217	65	64.7
13	48		19	5	162	161	18
14	53		16	12	414	247	44
15	54	46	32	21	401	371	73.6
16	57	32		17	415	140	3.5
17	58	24		2	242	228	72.8
18	58		20	25	289	157	27.4
19	62	37	31	20	403	293	64.2
20	67		41	28	416	403	10.6
21	69	36	30	24	381	361	
22	70	35	23	27	366	342	45.8
23	74	42	44	23	368	363	9
24	75	40	31	21	386	327	1.4
25	78	46		24	400	400	1
26	78		4	6	389	112	26.7

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27	82	48	36	27	381	316	34
28	83	35	32	26	382	349	22.2
29	85	45	33				
30	85	38	35	26	411	394	
31	89	39	39	25	393	355	23.9
32	94	39	37	26	409	344	
33	94	48	45	28	411	398	44.7
34	97	47	42	27	395	395	
35	98	41	35	24	382	342	2.8
36	monolingual	40	36	28	383	370	
37	monolingual	38	36	28	399	359	
38	monolingual	34	36	25	359	305	
39	monolingual	42	32	24	403	401	
40	monolingual	47	41	24	405	384	
41	monolingual	31	35	23	416	394	
42	monolingual	46	37	29	416	384	
43	monolingual	39	33	27	380	349	
44	monolingual	43	37	26	415	399	
45	monolingual	44	22	25	407	367	
46	monolingual	44	28	26	416	414	
47	monolingual	32	52	25	408	394	
48	monolingual	38	29	28	382	351	
49	monolingual	43	43	24	410	398	
50	monolingual	48	46	28	409	399	
51	monolingual	42	26	28	409	363	
52	monolingual	45	30	27	412	412	
53	monolingual	33	22	18	403	342	
54	monolingual	41	42	29			
55	monolingual	49	31	24	402	394	
56	monolingual	51	43	24	416	369	
57	monolingual	48	55	28	416	405	
58	monolingual	50	57		402	398	
59	monolingual	41	53		408	370	
60	monolingual	37	38		408	408	
61	monolingual	24		21	395	276	
62	monolingual	39	42	26	392	369	
63	monolingual			24	295	212	
64	monolingual	41	34	28	406	404	
65	monolingual	44	46	28	416	416	
66	monolingual	40	40	24	418	414	
67	monolingual	43	52	26	407	407	

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68	monolingual		17	23	345	215	
69	monolingual		43	29	413	411	
70	monolingual		24	26	397	392	
71	monolingual		43	25	407	400	

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Table 4. Number of children within the exposure category assigned to each K-means cluster analysis on children’s scores in the BPVS III, English SETK-2, CDI word comprehension and word production. The last column shows the mean distance between the two clusters for each measure.

		Bilingual <60%	Bilingual >60%	Monolingual = 100%	Distance between clusters
BPVS III	Cluster 1	12	2	6	22.13
	Cluster 2	3	14	28	
English SETK-2	Cluster 1	9	1	0	17.3
	Cluster 2	5	15	32	
CDI Comprehension	Cluster 1	9	0	0	266.7
	Cluster 2	9	16	35	
CDI Production	Cluster 1	14	1	2	243.5
	Cluster 2	4	15	33	



## LANGUAGE EXPOSURE AND BILINGUAL SCREENING

## Figure captions

Fig. 1. Relationship between percentage of English exposure and the English language assessment: BPVS III ( $n = 31$ ), English SETK-2 ( $n = 30$ ), PLS 4 Auditory ( $n = 21$ ), Oxford CDI Comprehension ( $n = 34$ ) and Production ( $n = 34$ ).

Fig. 2. Relationship between percentage of English exposure and the proportion of words that bilingual children ( $n = 30$ ) produce in each CDI (in their Additional Language: diamonds; in English: squares).

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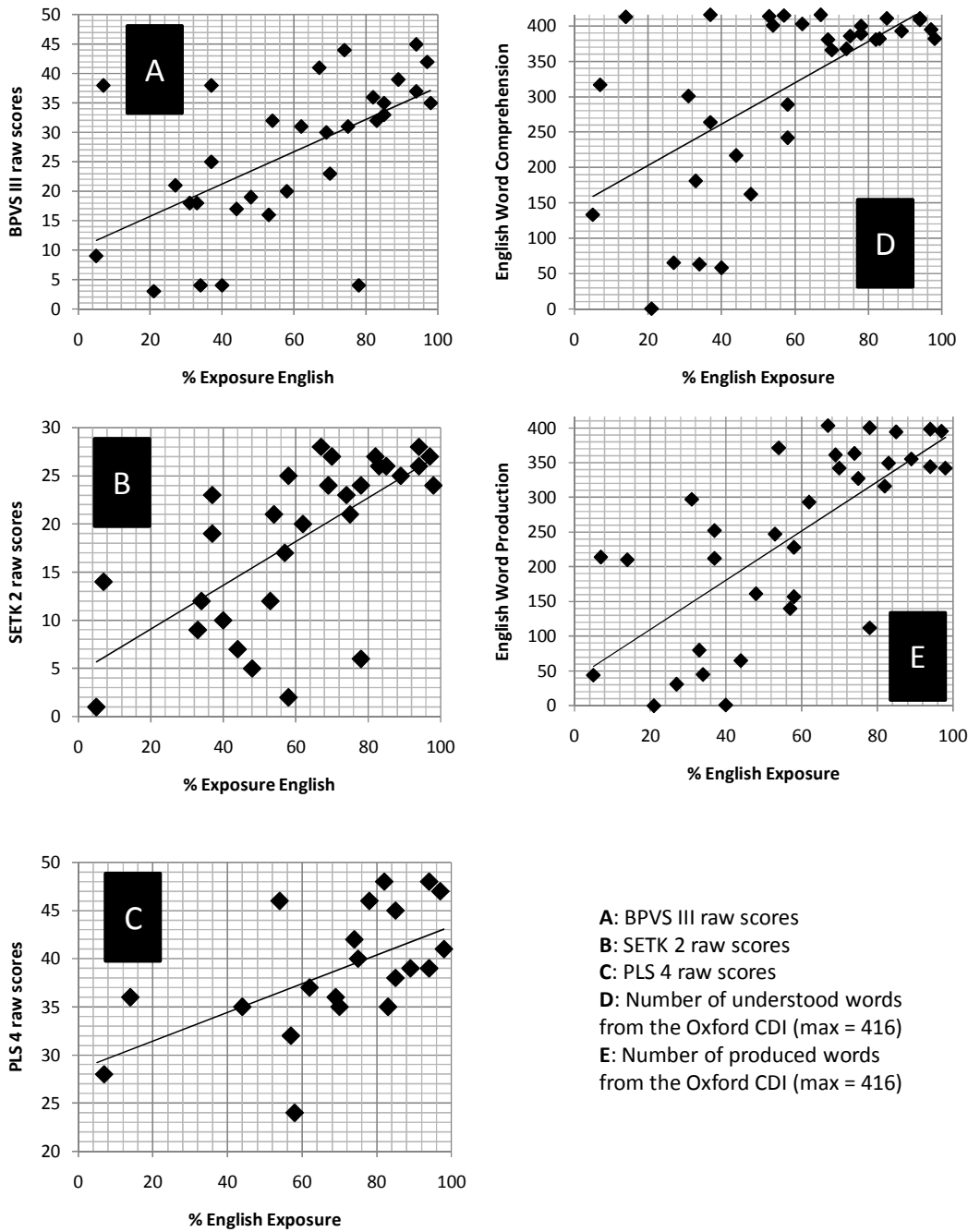


Figure 1

## LANGUAGE EXPOSURE AND BILINGUAL SCREENING

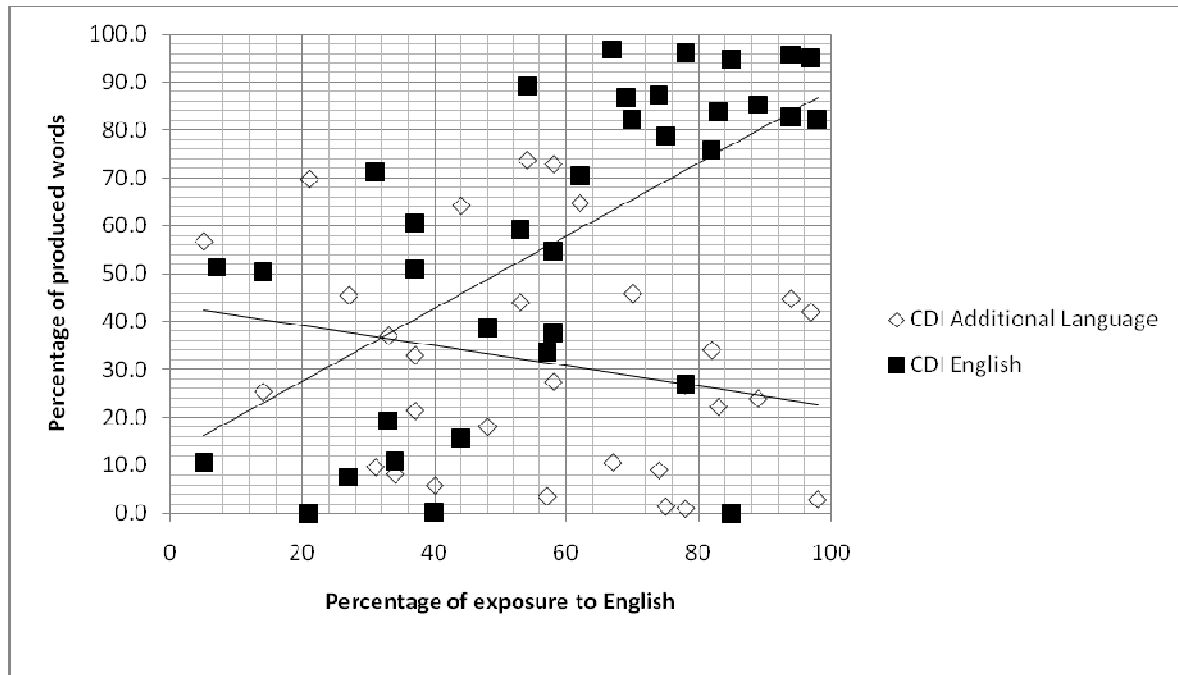


Figure 2

LANGUAGE EXPOSURE AND BILINGUAL SCREENING

Appendix 1

*Adapted English SETK-2*

*Objects*

- 1 Key
- 2 doll, dolly, baby, child
- 3 knife
- 4 ball, football
- 5 pencil, pen, felt tip, crayon, colourer
- 6 book, picture book,

*Pictures*

- 7 Car, types of car, e.g. VW
- 8 Chair, seat
- 9 house, hut, villa, home, flat
- 10 clock, alarm clock, tick tock
- 11 Swing
- 12 Tree
- 13 Apple
- 14 Fork
- 15 Scissors, snip snip
- 16 Eyes, eye
- 17 duck, goose, quack quack
- 18 cup, beaker
- 19 pig, oink oink, piglet, sow
- 20 Bus
- 21 butterfly
- 22 pear
- 23 comb
- 24 star
- 25 cake, muffin, bun
- 26 bear, teddy, teddy bear, polar bear
- 27 train,
- 28 brush
- 29 fridge
- 30 petrol station, garage

## LANGUAGE EXPOSURE AND BILINGUAL SCREENING

## Appendix 2

*Exposure Questionnaire: Calculating percentage of English and non-English input***Evaluation of the amount of exposure to English and to an Additional Language****INSTRUCTIONS**

Each parent will take a different route through this part of the questionnaire.  
Can you write the answers in column C next to the answer which is correct for this particular child

**Section A: Language(s) spoken in the home**

Do you and your partner....? (Can you circle your situation and go to the section indicated)

- |    |   |                        |
|----|---|------------------------|
| a) | This child hears 1 language, English.   | <b>Go to Section D</b> |
| b) | This child hears 2 languages, because <u>both parents</u> speak to her using another language (for example, they both speak Russian).   | <b>Go to Section B</b> |
| c) | This child hears 2 languages, because <u>one of the parents</u> speaks to her using another language (for example, Mum speaks Spanish and Dad speaks English).  | <b>Go to Section C</b> |
| d) | This child hears 3 languages, because each parent speaks a different language to the child (for example, Mum speaks Spanish and Dad Russian).   | <b>Go to Section D</b> |
| e) | This child hears 3 languages, because Mum and Dad speak another language to the child, but also because another person (a grandparent or a childminder for example) speaks a third language (for instance, Mum and Dad speak Spanish and the child has a French nanny). | <b>Go to Section D</b> |

**Section B: Both parents speak the same additional language to the child (let's refer to it as Additional Language)**

- |   |  |                      |
|---|--|----------------------|
| 1 | Can you please write here what is the Additional Language (e.g. Spanish)   | <input type="text"/> |
| 2 | Write the number of hours a week in average your child spends in an <u>English speaking</u> nursery/day care/preschool/childminder/relative or friend. | <input type="text"/> |
| 3 | Write the number of hours in average your child spends sleeping per 24 hours   | <input type="text"/> |

LANGUAGE EXPOSURE AND BILINGUAL SCREENING

4	Does the mother of this child ... (please write 1 in the corresponding cell)	
a)	always speak Additional Language to your child	
b)	usually speak Additional Language to your child	
c)	speak English to your child about half the time	
d)	usually speak English to your child	
e)	always speak English to your child	
5	Does the father of this child...(please write 1 in the corresponding cell)	
a)	always speaks Additional Language to your child	
b)	usually speaks Additional Language to your child	
c)	speaks English to your child about half the time	
d)	usually speaks English to your child	
e)	always speaks English to your child	
6	When you and your partner are together with this child, who speaks most to the child? (please write 1 in the appropriate cell)	
a)	Mother	
b)	Father	
c)	we both speak to this child an equal amount	
7	If there are certain days or parts of certain days in a typical week when only you or your partner are with your child (e.g. father always takes care of child on Saturday afternoons).	
	Write the <u>number of hours</u> per week when your child is with her mother only.	
	Write the <u>number of hours</u> per week when your child is with her father only	
	Percentage of exposure to English	
	Please go to Section D	

Section C: One parent speaks English, the other parent speaks an additional language to the child (let's refer to it as Additional Language)

1	Can you please write here what is the Additional Language (e.g. Spanish)	French
2	Who speaks English? Please write 1 if it is the mother and 2 if it is the father.	2
3	Write the number of hours a week in average your child spends in an <u>English speaking</u> nursery/day care/preschool/childminder/relative or friend.	21
4	Write the number of hours in average your child spends sleeping per 24 hours	11
5	The English speaking parent....(please write 1 in the corresponding cell)	

## LANGUAGE EXPOSURE AND BILINGUAL SCREENING

- a) always speaks English to your child
- b) usually speaks English to your child
- c) speaks Additional Language to your child about half the time
- d) usually speaks Additional Language to your child
- e) always speaks Additional Language to your child

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6 The Additional Language speaking parent...(please write 1 in the corresponding cell)

- a) always speaks Additional Language to your child
- b) usually speaks Additional Language to your child
- c) speaks English to your child about half the time
- d) usually speaks English to your child
- e) always speaks English to your child

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7 When you and your partner are together with this child, who speaks most to the child? (please write 1 in the appropriate cell)

- a) The English speaking parent
- b) The Additional Language speaking parent
- c) we both speak to this child an equal amount

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8 If there are certain days or parts of certain days in a typical week when only you or your partner are with your child (e.g. father always takes care of child on Saturday afternoons).

Write the number of hours per week when your child is with the English speaking parent only.

10
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Write the number of hours per week when your child is with the Additional Language speaking parent only.

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Percentage of exposure to English

0.35
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Please go to Section D

<b>Section D</b>	<b>All parents, please fill in this section</b>
------------------	---

1 What is the mother's highest educational qualification? Please write 1 after the corresponding case.

- No qualifications
- Below standard for a pass on the school-leaving examination
- O-levels
- A-levels
- Tertiary vocational qualifications
- An undergraduate degree
- A postgraduate degree

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2 What is the father's highest educational qualification? Please write 1 after the corresponding case.



LANGUAGE EXPOSURE AND BILINGUAL SCREENING

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	No qualifications	
	Below standard for a pass on the school-leaving examination	
	O-levels	
	A-levels	
	Tertiary vocational qualifications	
	An undergraduate degree	1
	A postgraduate degree	
3	What is the mother's occupation?	Teacher
4	What is the father's occupation?	Estate Agent
5	Does your child have older siblings? Please write the ages of the older siblings:	Age
	Sibling 1	4
	Sibling 2	
	Sibling 3	
	Sibling 4	
6	Please enter your child's date of birth:	01/01/2008
	Please enter today's date:	01/06/2010
7	Please enter your child's gender (1 = girl, 2 = boy):	1
8	Does your child have any identified hearing problem? (1 if yes, and please write more below)	
9	Was your child more than 6 weeks premature? (1 if yes)	
10	Does your child have any identified developmental delay? (1 if yes, and please write more below)	
11	Where was your child born?	UK
12	How long have you been living in an English-speaking country for?	4 years
	Identification code (internal use)	

## LANGUAGE EXPOSURE AND BILINGUAL SCREENING

## Appendix 3

*Details of the calculation of percentage of English exposure in a typical week of a toddler in the last year of life*

**A. Input from the parents:**

Number of hours a week in English-speaking nursery/childminder/playgroup = N

Number of sleeping hours per night = S

Does the Mother always speak the Additional Language (AL) to the Child, or usually, or equally often English and the AL, or usually English, or always English (5 possible responses) = M

Does the Father always speak the Additional Language to the Child, or usually, or equally often English and the AL, or usually English, or always English (5 possible responses) = F

When together, who speaks most to the child? Mother, Father or Both = Most

Number of hours per week spent with Mother only = HM

Number of hours per week spent with Father only = HF

**B. What does the calculation entail:**

1. **Assign a percentage to M and F, to estimate the proportion of English in each parent's input to the child.**

If M (or F) = Always AL then ME (or FE) = 100

If M (or F) = Usually AL then ME (or FE) = 75

If M (or F) = Equally AL and English then ME (or FE) = 50

If M (or F) = usually English then ME (or FE) = 25

If M (or F) = always English then ME (or FE) = 0

2. **Correct HM and HF to give more weight to the time spent with the Mother, as it is found usually that fathers tend to produce less verbal output to their child, therefore directly impacting on the amount of exposure in English and the Additional Language (e.g. Pancsofar & Vernon-Feagans, 2006).**

Corrected time with Mother = CHM =  $HM \times 4/3$

Corrected time with Father = CHF =  $HF \times 2/3$

LANGUAGE EXPOSURE AND BILINGUAL SCREENING

3. Assign a value (MI to Most), to give more weight to the Mother's input. What is obtained corresponds to the percentage of the Mother's input during the time when both parents are with the child.

If Most = Mother then MI = 90

If Most = Father then MI = 50

If Most = Both then MI = 70

4. Calculate the number of hours per week with both parents together

$$TBP = 7(24 - S) - N - HM - HF$$

5. Calculate the total number of hours of English exposure in a week (E) with the following formula:

E = English from mother when mother alone + English from father when father alone + English from mother when both parents together + English from father when both parents together + English from nursery or equivalent

$$E = \frac{CHM(100-ME)}{100} + \frac{CHF(100-FE)}{100} + N + 0.01 \cdot TBP \cdot \frac{MI(100-ME)}{100} + 0.01 \cdot \frac{TBP(100-MI)(100-FE)}{100} \quad \text{With}$$

English from mother when mother alone =  $CHM(100-ME)/100$

English from father when father alone =  $CHF(100-ME)/100$

English from mother when both parents together =  $0.01 \cdot TBP \cdot MI(100-ME)/100$

English from father when both parents together =  $0.01 \cdot TBP(100-MI)(100-FE)/100$

6. Calculate the percentage of exposure to English

$$P = \frac{E}{7(24 - S)}$$

## LANGUAGE EXPOSURE AND BILINGUAL SCREENING

FOOTNOTES

<sup>1</sup> When parents differed with respect to their education background, the highest level attained was considered (Bello, Giannantoni, Pettenati, Stefanini and Caselli, 2012; Caselli, Paqualetti and Stefanini, 2007; Doblhammer, Hoffmann, Muth, Westphal, and Kruse, 2009).

<sup>2</sup> During extensive piloting and in this study, we did not encounter the case of families in which English is the only language spoken at home with an Additional Language being spoken in a nursery for example; therefore it was not included in the calculations. However, if during the conversation with the experimenter this would have emerged, the child would have been excluded from participation. However, an additional question would be very easy to include it in a later version of the EQ. In addition, for reasons of simplicity at this stage, we did not provide calculations for families in which more than two languages are spoken.

<sup>3</sup> The translation of the German test was initially piloted at the University of Manchester and Leipzig, and it was found equivalent performance in raw scores for 30 month-old German and English children (Dittmar, unpublished doctoral dissertation).

<sup>4</sup> One parent was actually a Czech speaker but understood Slovak, which is a dialectal variant and was thus instructed to check off if the child said the Czech equivalent of any of the Slovak words.

<sup>5</sup> The Punjabi translation of the Oxford CDI was only used for the analysis in the Additional Language.

<sup>6</sup> Similar regression analyses carried out using the raw scores for the BPVS III, PLS 4 and English SETK-2 reported equal outcomes.

<sup>7</sup> The variance differed until the cut-off point was reached, i.e. between the group of toddlers with less than 60% exposure to English on one hand and on the other hand, the monolingual children plus the bilingual toddlers with 60% or above exposure to English.

LANGUAGE EXPOSURE AND BILINGUAL SCREENING

<sup>8</sup> This particular analysis for the PLS 4 scores was not carried out, as 15 of 36 bilingual toddlers did not complete this test.

<sup>9</sup> To make sure that this effect was not due to chance, we also carried out the procedure, removing children’s data one by one, until there were only 10 bilingual toddlers left. No significant t-test value was observed.

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